2004 Annual Summary of Water Quality Observations in Select Streams of Chesterfield County

Third Branch downstream of Spring Run Road, September 2004.

Office of Water Quality

Compiled January 2005

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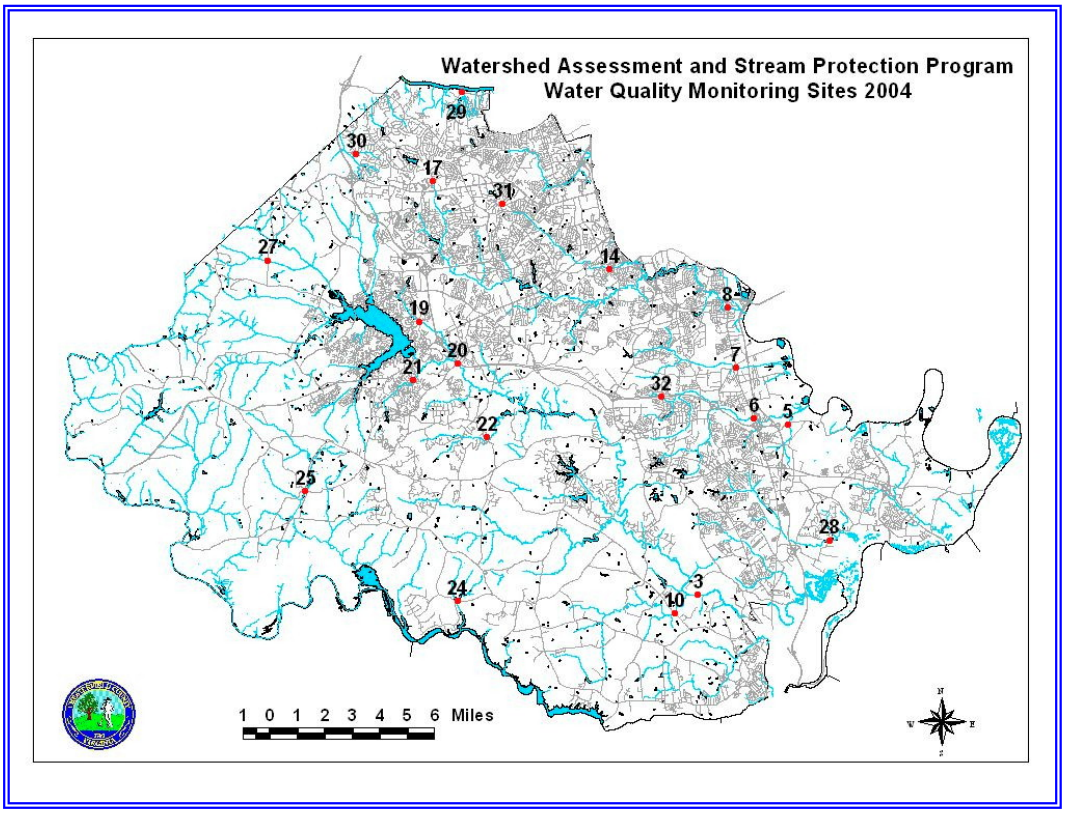
Introduction:

This report presents the physical and chemical water quality data collected by Chesterfield County's Office of Water Quality for the period of January through December of 2004. As a component of Chesterfield County's Watershed Assessment and Stream Protection Program (WASP), twenty stream sites are investigated monthly to monitor the general state of water quality throughout the County and to compile a database for trending and comparison of basic physical and chemical parameters. This report represents the third year of monitoring at many of these sites.

Sites were selected by a careful review of maps produced from the County's Geographic Information System. Streams were selected to represent a variety of sizes and watershed land uses. Following the map analysis, field surveys were conducted in order to verify site locations, accessibility and feasibility. A list of stream sites was finalized and assigned a specific reference identifier consisting of the prefix "WQ" (*i.e.* water quality) followed by a sequentially increasing number (01 – 32) to differentiate them from other WASP program sites. In 2004, a rotating system was introduced where monitoring continued at a core group of original sites and new sites in previously unmonitored areas and watersheds were introduced. The basis of this decision was to provide better coverage of the County and to gather data from different stream systems. Monitoring in 2004 followed the general methods and protocols used in previous years.



Methods:

Stream sites were sampled monthly over a range of baseflow conditions. Physical parameters were measured *in situ* by use of a Hydrolab® Minisonde 4a water quality multiprobe in conjunction with Surveyor 4a data logger system. The Hydrolab® Minisonde multiprobe was calibrated using commercially prepared buffer solutions prior to deployment to the field. Parameters measured in the field included water temperature, pH, dissolved oxygen, conductivity and total dissolved solids. A semi-quantitative measure of flow was also obtained by recording the time it took for a float to travel a distance of one meter. Ambient air temperature was additionally noted.

Water quality samples were collected in 237 ml low-density polyethylene containers. Samples were obtained from the bank of each site just below the surface of the water by hand or by a long handled sampling pole and immediately placed in a cooler on ice for transfer to the water quality laboratory. Upon returning to the laboratory, sample information was recorded in a sample tracking logbook and assigned a unique number. Samples were then stored at $\leq 4^{o}C$ in the laboratory refrigerator until time of analysis. Care was taken to adhere to analytical holding times for specific analytes.

In the laboratory, a YSI 9100 series photometer was used to analyze samples for four parameters. Samples were analyzed for ammonia nitrogen, nitrate+nitrite nitrogen, phosphate phosphorus and turbidity. Additionally, total alkalinity and calcium hardness were analyzed on a quarterly basis. Palintest® environmental testing company methods specific to the photometer were used and generally reflected those outlined in *Standard Methods*.

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Quality Assurance and Quality Control:

For each parameter analyzed in the laboratory, Method Detection Limits (MDLs) were calculated (October, 2003) following the procedure outlined in Section 1030E of *Standard Methods*. Laboratory reporting limits were then determined from these MDLs. On the day of analysis, instrument calibration was verified using a set of photometer primary standards obtained from Palintest®. To insure analytical precision and accuracy, a pair of known quality control samples for ammonia nitrogen, nitrate nitrogen and phosphate phosphorus were analyzed. Values obtained were compared to the manufacturer's acceptable recovery limits and charted for record. Out of tolerance values were noted and evaluated for potential causes of error. Due to lack of availability, known concentrations for alkalinity and calcium hardness were not analyzed.

Sample replicates were analyzed every ten samples for each parameter and relative percent differences were calculated. Analytical blanks were used to in order to detect any potential contamination that may have occurred during sampling or sample preparation. Manufacturer's recommendations for preventive maintenance were followed for all instruments.

A summary of the tests, methods and reporting limits as well as applicable water quality standards for the analyses is outlined in table 1.

Table 1. Parameters and Analytical Methods.

Parameter	Analytical Method	Reporting Limit	Water Quality Standard	**Reference**
Dissolved Oxygen	Probe: Hydrolab® Minisonde	0.20 mg/L*	≥ 4.0 mg/L	VADEQ
pH	Probe: Hydrolab® Minisonde	0.20 units*	6.0 – 9.0 units	VADEQ
Conductivity	Probe: Hydrolab® Minisonde	1.0 µS/cm*	≤ 500 µS/cm	None
Total Dissolved Solids	Probe: Hydrolab® Minisonde	0.10 mg/L*	≤ 500 mg/L	PA State Standard
Temperature	Probe: Hydrolab® Minisonde	0.10 ^{o}C*	≤ 32 ^{o}C	VADEQ
Alkalinity	Palintest®: Alkaphot	10 mg/L	≥ 20 mg/L	DE, KY,& PA State Standard
Calcium Hardness	Palintest®: Calcicol	10 mg/L	≤ 85 = "soft"	None
Ammonia Nitrogen	Palintest®: Phenate	0.02 mg/L	0.04 mg/L Forested Area	Schueler, 1997b
Nitrate/Nitrite Nitrogen	Palintest®: Nitratest	0.02 mg/L	0.10 mg/L Nitrate+Nitrite	EPA, 2000
Phosphate Phosphorus	Palintest®: Phosphate LR	0.01 mg/L	0.01 mg/L Forested Area	Caraco, 2001
Turbidity	Palintest®: Turbidity	5 FTUs	4 FTUs	EPA, 2000
Flow	USGS: Float	0.01 m/s	None	None

**When a method detection limit was not applicable for a parameter, it was replaced by an estimation of accuracy based on manufacturer's specifications.*

Comparative Index of Chemical Water Quality:

The index of water quality developed for the 2002 and 2003 data to describe relative chemical water quality among the sites continued in 2004. Monthly water quality measurements were entered into an EXCEL spreadsheet and quality scores were assigned based upon values obtained by from literature and web based search of current Virginia, Mid-Atlantic States and Regional EPA water quality standards. The measurement scores were summed and compared to an ideal score (*i.e.* the score if all measurements met the standards). Cumulative percentile plot analysis resulted in a set of three criteria based upon natural breaks in the data (generally the 20th, 50th and 80th percentile). These data sets were categorically identified respectively as "high quality", "moderate quality" and "low quality". Annual median scores were calculated and used to characterize the overall chemical water quality for each site. It should be noted that the index describes only the *chemistry* of the water for identified parameters relative to the 2004 data set and should not be interpreted as a full measure of aquatic health. Other indices that incorporate benthic macroinvertebrate and instream habitat data may yield a different assessment and should not be compared to the results of this analysis. A copy of the EXCEL spreadsheet with the calculation will be made available for review upon request.

Site Descriptions and Summaries:

The following pages describe each site and contain a summary of the observations made during the course of the year. All photos depict upstream views unless otherwise noted. Left and right banks are referenced from the perspective looking upstream. Approximate instream sampling points are denoted by a red arrow.

Site Number WQ-03

Stream: Swift Creek

Site: Off Bank, At End of John Winston Jones Parkway, Behind Matoaca High School, Matoaca, Virginia

Latitude: 37° 17' 15.99025"
Longitude: 77° 27' 37.66647"

Watershed: Swift Creek

Stream Order: 4

Landuse: Forested and Low Density Residential; School ≈ 1000m Upstream of Site w/Package Sewer Treatment Facility

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/15/04	11.3	6.5	51	32.5	3.03	<0.02	0.19	0.01	<5	0.16	93.3
02/25/04	9.2	6.5	54	34.9	5.83	0.02	0.13	0.03	6	0.09	80.0
03/09/04	8.0	6.5	61	39.1	10.22	<0.02	0.05	0.03	8	0.12	80.0
*	*	*	*	*	*	*	*	*	*	*	
05/17/04	7.0	6.6	80	51.0	21.71	<0.02	0.15	0.02	<5	0.05	86.7
06/07/04	6.8	6.4	71	45.4	21.29	0.03	0.16	0.01	6	0.08	86.7
07/13/04	6.3	6.2	57	36.4	25.74	<0.02	0.12	0.09	10	0.03	73.3
08/10/04	6.0	5.9	51	32.6	22.56	<0.02	0.11	0.02	12	0.12	60.0
09/13/04	8.3	5.8	42	26.3	22.83	0.03	0.13	0.04	8	0.20	66.7
10/12/04	8.4	6.3	58	37.0	14.58	<0.02	0.12	0.03	8	0.08	73.3
11/16/04	11.3	6.7	48	31.0	9.40	0.03	0.09	0.03	12	0.21	73.3
12/14/04	11.0	6.6	50	31.9	7.78	0.02	0.12	0.01	10	0.17	80.0
Minimum	6.0	5.8	42	26.3	3.03	<0.02	0.05	0.01	<5	0.03	60.0
Median	**8.3**	**6.5**	**54**	**34.9**	**14.58**	**<0.02**	**0.12**	**0.03**	**8**	**0.12**	**80.0**
Maximum	11.3	6.7	80	51.0	25.74	0.03	0.19	0.09	12	0.21	93.3
2003 Median	***9.6***	***6.2***	***63***	***40.3***	***12.34***	***<0.02***	***0.08***	***0.02***	***9***	***0.13***	***80.0***
2002 Median	***7.2***	***6.3***	***98***	***62.7***	***17.81***	***<0.03***	***0.11***	***0.01***	*****	***0.06***	*****

Swift Creek is a perennial tributary of the Appomattox River that bisects the Piedmont and Alluvium region of Chesterfield County and represents one of the major watersheds of the county. It possesses a substrate comprised of sand, gravel and cobble with a number of small boulders present. The creek is, for the most part, sluggish, but exhibits high flows periodically through the year. Observations of water clarity indicated stained water conditions prevalent throughout the year. The stream's banks exhibit moderate to heavy degrees of erosion and are sparsely vegetated. The completed high school operates a package wastewater treatment facility which discharges to Swift Creek immediately downstream of the monitoring site.

Dominant riparian vegetation includes various species of hardwood trees and shrubs. Periphyton and algae growths were among the dominant instream biota noted throughout the year.

Samples were obtained from the left bank at a median depth of 0.10 meters. The annual median index score reflected waters of moderate quality. Dissolved oxygen concentrations, pH, conductivity and total dissolved solids concentration were all within normal expected ranges. Annual median calcium hardness (<10 mg/L $CaCO_3$) and annual median alkalinity (23 mg/L $CaCO_3$) were indicative of soft, well buffered water. Turbidity values ranged from <5 to 12 FTUs. Ammonia nitrogen concentrations remained low throughout the year and were similar to previous years' observations. Annual median values of nitrite+nitrate nitrogen and phosphate phosphorus were slightly higher in 2004 than in preceding years.

Site Number WQ-05

Stream: Redwater Creek

Site: Approximately 20 meters Upstream of Crossing of Coxendale Road, Chester, Virginia

Latitude: 37° 22' 38.73022"
Longitude: 77° 23' 59.62777"

Watershed: James River

Stream Order: 2

Landuse: Industrial with Scattered Forests; Railroad tracks run parallel to western bank of the stream and cross the creek upstream of the monitoring site; Sanitary sewer line runs parallel to east bank

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/15/04	11.3	6.2	119	76.0	4.51	0.10	0.38	<0.01	12	0.21	60.0
02/25/04	9.2	6.2	175	112.0	5.92	0.08	0.44	0.03	8	0.16	60.0
03/09/04	9.0	6.1	180	115.2	8.60	0.06	0.27	0.01	10	0.16	66.7
04/05/04	10.9	5.8	16	10.3	8.40	0.06	0.26	<0.01	12	0.12	53.3
05/17/04	7.7	6.3	151	96.8	21.09	0.05	0.22	<0.01	8	0.17	66.7
06/07/04	8.8	6.1	133	84.9	21.67	0.04	0.22	<0.01	10	0.14	73.3
07/13/04	7.1	6.2	131	83.8	25.06	0.07	0.18	0.10	10	0.09	66.7
08/10/04	6.6	5.9	114	73.0	21.99	0.06	0.20	0.01	14	0.13	60.0
09/13/04	8.9	5.7	92	59.3	21.57	0.08	0.18	0.01	28	0.29	60.0
10/12/04	8.4	5.9	126	81.1	14.36	0.07	0.19	0.01	16	0.22	60.0
11/16/04	11.1	6.4	110	70.4	8.97	0.24	0.20	0.01	12	0.13	60.0
12/14/04	11.7	6.3	113	72.3	6.93	0.09	0.25	0.01	14	0.13	60.0
Minimum	6.6	5.7	16	10.3	4.51	0.04	0.18	<0.01	8	0.09	53.3
Median	**8.9**	**6.1**	**123**	**78.6**	**11.67**	**0.07**	**0.22**	**0.01**	**12**	**0.15**	**60.0**
Maximum	11.7	6.4	180	115.2	25.06	0.24	0.44	0.10	28	0.29	73.3
2003 Median	***9.5***	***5.7***	***127***	***81.3***	***14.03***	***0.08***	***0.17***	***0.01***	***11***	***0.20***	***60.0***
2002 Median	***8.1***	***6.0***	***135***	***86.4***	***17.19***	***0.06***	***0.14***	***0.02***	*****	***0.22***	*****

Redwater Creek is a perennial tributary of the James River located in the Deep Coastal Plain region of Chesterfield County. Its substrate is comprised largely of sand, with gravel and cobble present downstream of the monitoring site. Redwater Creek possessed strong flows throughout the year with clear water observed during seven of the surveys. The banks of Redwater Creek were moderately eroded.

Dominant riparian vegetation was comprised of a variety of herbaceous plants, grasses and shrubs. Hardwood trees and shrubs were present upstream of the monitoring site. The east bank vegetation that was cleared for routine maintenance of the sanitary sewer easement in 2003 exhibited extensive growth during 2004. Iron bacteria, periphyton, amphibians and fish were noted during the year.

Samples were obtained from the left bank at a median depth of 0.05 meters. Annual median index scores indicated low chemical water quality. Physical parameters were within expected ranges during 2004 and were similar to those observed in preceding years. The stream's water was extremely soft (annual median calcium hardness <10 mg/L $CaCO_3$) and generally well buffered (annual median alkalinity 30 mg/L $CaCO_3$). Annual median ammonia concentrations were slightly elevated and were similar to the 2002 and 2003 observations. Nitrate +nitrite levels were higher than in previous years. Phosphate phosphorus concentrations continued to remain acceptable.

Site Number WQ-06

Stream: Proctors Creek

Site: Approximately 75 meters Upstream of the Bridge Crossing of Jefferson Davis Highway, Chester, Virginia

Latitude: 37° 22' 50.66538"
Longitude: 77° 25' 20.23005"

Watershed: James River

Stream Order: 3

Landuse: Mixed Commercial with Forests; Automobile Dealership on South Bank of Site

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/15/04	12.0	6.2	60	38.4	3.57	0.06	0.50	0.03	6	0.62	60.0
02/25/04	9.7	6.3	73	46.6	5.79	0.05	0.47	0.03	10	0.50	53.3
03/09/04	8.7	6.1	76	48.8	8.28	0.07	0.26	0.02	18	0.81	53.3
04/05/04	11.3	6.0	68	43.5	9.05	0.08	0.26	0.02	10	0.61	60.0
05/17/04	7.7	6.5	99	63.5	22.10	0.09	0.33	0.03	12	0.37	53.3
06/07/04	9.1	5.9	72	45.8	21.62	0.02	0.24	0.01	12	0.57	60.0
07/13/04	7.7	6.3	69	44.6	25.81	<0.02	0.13	0.07	10	0.56	73.3
08/10/04	6.6	5.9	64	40.5	22.75	0.03	0.18	0.02	10	0.44	66.7
09/13/04	8.4	5.8	59	38.0	21.77	<0.02	0.18	0.01	12	0.53	66.7
10/12/04	9.3	5.9	66	42.2	14.13	<0.02	0.15	0.01	10	0.22	73.3
11/16/04	11.9	6.3	60	38.5	7.55	0.02	0.20	<0.01	10	0.49	80.0
12/14/04	12.5	6.3	59	38.0	6.10	0.06	0.32	0.01	8	0.41	66.7
Minimum	6.6	5.8	59	38.0	3.57	<0.02	0.13	<0.01	6	0.22	53.3
Median	**9.2**	**6.1**	**67**	**42.9**	**11.59**	**0.04**	**0.25**	**0.02**	**10**	**0.52**	**63.3**
Maximum	12.5	6.5	99	63.5	25.81	0.09	0.50	0.07	18	0.81	80.0
2003 Median	***9.1***	***5.9***	***71***	***45.4***	***13.71***	***<0.02***	***0.14***	***0.01***	***10***	***0.63***	***73.3***
2002 Median	***7.2***	***5.9***	***96***	***61.8***	***17.23***	***<0.03***	***0.09***	***0.06***	*****	***0.13***	*****

Proctors Creek is a perennial tributary of the James River located in the Deep Coastal Plain region of Chesterfield County. Its substrate is comprised largely of sand, gravel and cobble. Water flow was swift and strong throughout the year. Clear water was observed on nine of the twelve survey dates. The banks of Proctors Creek are well vegetated with very little erosion present.

Dominant riparian vegetation was comprised primarily of trees and shrubs. Periphyton was abundant, with algae and macroinvertebrates observed during the early part of the year.

Samples were obtained from the right bank at a median depth of 0.05 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were largely within expected ranges during 2003 and were similar to observations made during the previous year. The stream's water was extremely soft (annual median calcium hardness <10 mg/L $CaCO_3$) and well buffered (annual median alkalinity 28 mg/L $CaCO_3$). Turbidity values remained similar to 2003 observations. The annual median ammonia nitrogen concentration was slightly higher in 2004 than in previous years. Likewise, the annual median nitrate+nitrite nitrogen concentration was elevated, almost twice as much as in 2003. The annual median phosphate phosphorus value observed for 2004 (0.02 mg/L as P) was similar to the preceding year's concentration.

Site Number WQ-07

Stream: Kingsland Creek

Site: 25 meters Upstream of Bridge Crossing of Jefferson Davis Highway, Bellwood, Virginia

Latitude: 37° 24' 27.92933"
Longitude: 77° 26' 02.39536"

Watershed: James River

Stream Order: 3

Landuse: Mixed Commercial and Residential

Gradient: High

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/15/04	12.3	6.2	68	43.5	4.51	0.03	0.80	<0.01	<5	0.31	80.0
02/25/04	10.1	6.4	82	57.7	5.80	0.05	0.85	0.07	<5	0.28	66.7
03/09/04	8.5	6.1	73	46.6	8.17	<0.02	0.38	0.03	8	0.29	66.7
04/05/04	11.7	6.0	70	45.0	8.68	<0.02	0.55	0.01	<5	0.17	80.0
05/17/04	7.9	6.3	106	67.7	20.16	0.08	0.95	0.09	<5	0.21	66.7
06/07/04	9.4	6.1	90	57.5	19.65	<0.02	0.60	0.02	10	0.17	60.0
07/13/04	8.1	6.2	96	61.6	23.97	<0.02	0.70	0.02	<5	0.40	73.3
08/10/04	6.9	6.0	86	55.0	21.40	<0.02	0.55	0.01	6	0.41	73.3
09/13/04	8.6	5.8	70	44.7	20.84	0.03	0.42	0.05	12	0.15	53.3
10/12/04	9.6	6.0	80	51.2	14.21	<0.02	0.60	0.04	6	0.39	66.7
11/16/04	12.7	6.2	61	38.9	8.70	<0.02	0.24	0.04	12	0.57	60.0
12/14/04	12.0	6.3	63	40.6	7.06	<0.02	0.37	0.08	<5	0.51	80.0
Minimum	6.9	5.8	61	38.9	4.51	<0.02	0.24	<0.01	<5	0.15	53.3
Median	**9.5**	**6.1**	**76**	**48.9**	**11.46**	**<0.02**	**0.58**	**0.03**	**<5**	**0.30**	**66.7**
Maximum	12.7	6.4	106	67.7	23.97	0.08	0.95	0.09	12	0.57	80.0
2003 Median	***10.0***	***5.9***	***88***	***56.3***	***13.59***	***<0.02***	***0.38***	***0.02***	***7***	***0.31***	***66.7***
2002 Median	***9.2***	***6.1***	***128***	***82.2***	***16.31***	***<0.03***	***0.27***	***0.04***	*****	***0.39***	*****

Kingsland Creek is a perennial tributary of the James River located in the Low River Terrace and Alluvium region of Chesterfield County. Its substrate is comprised primarily of gravel and cobble intermixed with sand. Kingsland Creek is a relatively swift moving stream with clear waters. The banks of Kingsland Creek are well vegetated with only slight erosion present. A large grassy area that is part of a motel complex is present downstream of the monitoring site along the south bank. Extremely high flows from Tropical Storm Gaston resulted in devastating flooding and damaged adjacent properties at this site during late August.

Dominant riparian vegetation was comprised of trees, shrubs and grasses. A variety of instream life was observed during the year and included iron bacteria, periphyton, algae and macroinvertebrates.

Samples were obtained from the left bank at a median depth of 0.02 meters. Annual median index scores indicated that the stream exhibited moderate quality waters, due primarily to high nitrate+nitrite nitrogen concentrations. Physical parameters were within normal expected ranges during 2004. The stream's water was very soft (annual median calcium hardness 13 mg/L $CaCO_3$) and generally well buffered (annual median alkalinity 20 mg/L $CaCO_3$). Turbidity was low during 2004, seldom exceeding 10 FTUs. Nitrate+nitrite nitrogen levels remained high (annual median concentration 0.38 mg/L as N) throughout the year as in prior years, indicative of the more urban nature of this watershed. Phosphate phosphorus and ammonia nitrogen concentrations were not exceedingly elevated and were similar to values observed in 2002 and 2003.

Site Number WQ-08

Stream: Falling Creek

Site: Immediately Upstream of the Old Stone Bridge in Falling Creek Wayside Park, Bellwood, Virginia

Latitude: 37° 26' 23.12287 "
Longitude: 77° 26' 21.08859"

Watershed: Falling Creek

Stream Order: 3

Landuse: Mixed Commercial and Residential

Gradient: High

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/15/04	11.9	6.8	99	63.5	4.52	0.02	0.51	0.05	<5	0.46	73.3
02/25/04	9.8	6.7	132	84.4	6.57	0.02	0.70	0.04	6	0.45	66.7
03/09/04	7.8	7.0	130	83.1	11.17	<0.02	0.26	0.02	<5	0.42	80.0
04/05/04	10.7	6.6	124	79.5	10.75	<0.02	0.27	<0.01	<5	0.34	86.7
05/17/04	7.9	7.0	118	76.0	24.55	<0.02	0.31	0.03	<5	0.33	80.0
06/07/04	8.7	6.7	111	71.2	23.48	<0.02	0.33	0.01	<5	0.20	86.7
07/13/04	7.7	6.6	95	60.6	27.46	0.03	0.14	0.07	6	0.54	80.0
08/10/04	6.4	6.4	79	50.8	25.71	0.05	0.21	0.04	<5	0.46	80.0
09/13/04	8.7	6.5	88	56.5	23.11	0.07	0.26	0.10	10	0.36	60.0
10/12/04	8.9	6.7	112	71.3	16.55	<0.02	0.32	0.02	8	0.17	66.7
11/16/04	12.2	6.8	83	53.0	9.28	0.02	0.21	0.09	22	0.21	66.7
12/14/04	11.8	6.9	90	57.5	8.17	0.02	0.38	0.03	12	0.18	60.0
Minimum	6.4	6.4	79	50.8	4.52	<0.02	0.14	<0.01	<5	0.17	60.0
Median	**8.8**	**6.7**	**105**	**67.4**	**13.86**	**0.02**	**0.29**	**0.04**	**<5**	**0.35**	**76.7**
Maximum	12.2	7.0	132	84.4	27.46	0.07	0.70	0.10	22	0.54	86.7
2003 Median	***10.2***	***6.6***	***105***	***67.3***	***13.96***	***0.02***	***0.25***	***0.02***	***7***	***0.45***	***73.3***
2002 Median	***8.9***	***6.5***	***130***	***83.5***	***19.58***	***0.04***	***0.15***	***0.02***	*****	***0.31***	*****

Falling Creek is a perennial tributary of the James River that bisects the northeastern portion of Chesterfield County and represents one of the major watersheds of the county. Site WQ-08 lies within the Low River Terrace and Alluvium region where its substrate is comprised primarily of large particles such as gravel, cobble, boulders and bedrock. At this site, Falling Creek is a relatively swift moving stream. The water's coloration was largely stained (nine occasions) with clear water observed during the remaining months. The banks of Falling Creek are well vegetated with a limited amount of erosion present. Extremely high flows from Tropical Storm Gaston resulted in devastating flooding and severe damage to the Old Stone Bridge and nearby properties at this site during late August.

Dominant riparian vegetation was comprised primarily of trees and shrubs with a moderate amount of grassy and herbaceous growth. As in prior years, periphyton and algae dominated instream life.

Samples were obtained from the left bank at a median depth of 0.10 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were within normal expected ranges during 2004. The stream's water was soft (annual median calcium hardness (15 mg/L $CaCO_3$) and generally well buffered (annual median alkalinity 25 mg/L $CaCO_3$). Turbidity values were typically low and ranged from <5 to 22 FTUs during 2004. The annual median concentration of nitrate+nitrite nitrogen remained slightly elevated as in 2003. Ammonia nitrogen concentrations were comparable to values observed in 2003. The annual median phosphate phosphorus concentration (0.04 mg/L as P) was twice as high as previously observed values.

Site Number WQ-10

Stream: Franks Branch

Site: Immediately Downstream of the Woodpecker Road Bridge Crossing, Matoaca, Virginia

Latitude: 37° 16' 42.61307"
Longitude: 77° 28' 34.84916"

Watershed: Swift Creek

Stream Order: 3

Landuse: Rural Residential with Fields and Forests; Some recent scattered development

Gradient: Low

View is downstream of bridge

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/15/04	12.1	6.1	35	22.5	2.37	<0.02	0.15	0.03	<5	0.48	86.7
02/25/04	9.8	5.9	37	23.8	5.20	0.10	0.14	0.01	8	0.37	66.7
03/09/04	8.6	5.7	38	24.3	7.80	<0.02	0.13	0.03	<5	0.45	80.0
04/05/04	11.2	5.5	39	24.7	8.08	<0.02	0.07	0.01	10	0.34	80.0
05/17/04	7.7	6.3	47	29.8	20.17	0.02	0.19	0.03	12	0.28	66.7
06/07/04	8.9	6.1	43	27.7	19.74	<0.02	0.13	0.03	8	0.37	73.3
07/13/04	7.3	6.1	47	30.0	23.73	<0.02	0.11	0.04	10	0.36	73.3
08/10/04	6.8	5.6	40	25.6	20.79	<0.02	0.08	0.02	12	0.46	66.7
09/13/04	9.1	5.6	35	22.4	21.08	0.02	0.09	0.06	14	0.49	66.7
10/12/04	9.2	6.0	41	25.9	14.22	<0.02	0.09	0.03	10	0.27	80.0
11/16/04	12.2	6.4	37	23.5	8.35	<0.02	0.08	0.09	<5	0.31	93.3
12/14/04	12.0	6.3	36	23.3	6.90	<0.02	0.10	0.01	<5	0.26	100.0
Minimum	6.8	5.5	35	22.4	2.37	<0.02	0.07	0.01	<5	0.26	66.7
Median	**9.2**	**6.0**	**38**	**24.5**	**11.29**	**<0.02**	**0.11**	**0.03**	**9**	**0.37**	**76.7**
Maximum	12.2	6.4	47	30.0	23.73	0.10	0.19	0.09	14	0.49	100.0
2003 Median	***10.1***	***5.7***	***41***	***26.1***	***12.29***	***<0.02***	***0.07***	***0.01***	***6***	***0.42***	***86.7***
2002 Median	***10.0***	***6.0***	***53***	***34.1***	***14.03***	***<0.03***	***0.04***	***0.06***	*****	***0.15***	*****

Franks Branch is a perennial tributary of Swift Creek and is located in the Piedmont and Alluvium region of Chesterfield County. Its substrate is comprised primarily of sand and gravel. Franks Branch exhibited good flow throughout 2004. During the monthly surveys, clear water was noted only three times with the remainder of the observations characterized as stained. Vegetation is present along the stream's bank with slight to moderate areas of erosion present. A large quantity of sand deposited along the right bank in September 2003 remains in place.

Dominant riparian vegetation was comprised primarily of hardwood trees and shrubs with grasses and herbaceous growth present during the summer months. A variety of instream biota including periphyton, algae, submerged and emergent plants were observed at this site during the year.

Samples were obtained from the right bank at a median depth of 0.10 meters. The annual median index score indicated moderate chemical water quality. The waters were well oxygenated throughout the year however five of the pH readings failed to meet the state standard during 2004. The stream's water was extremely soft (annual median calcium hardness <10 mg/L $CaCO_3$) and generally well buffered (annual median alkalinity 23 mg/L $CaCO_3$). Turbidity values were typically low during 2004 and ranged from <5 to 14 FTUs. Annual median concentrations of ammonia and nitrate+nitrite nitrogen levels were within expected limits. Annual median phosphate concentrations were slightly elevated.

Site Number WQ-14

Stream: Pocoshock Creek

Site: 10 meters Upstream of the Turner Road Bridge Crossing, Midlothian, Virginia

Latitude: 37° 27' 39.25271"
Longitude: 77° 30' 59.88790"

Watershed: Falling Creek

Stream Order: 2

Landuse: Low Density Residential

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/15/04	11.7	6.7	109	70.0	3.85	0.05	0.34	0.02	8	0.23	60.0
02/25/04	10.1	6.8	123	78.6	6.38	<0.02	0.39	0.06	8	0.21	66.7
03/09/04	8.7	6.7	153	98.1	8.52	<0.02	0.38	0.05	8	0.24	66.7
04/05/04	10.9	6.6	125	79.7	10.59	<0.02	0.23	0.02	<5	0.29	80.0
05/17/04	6.7	6.7	131	83.7	21.52	<0.02	0.44	0.07	<5	0.11	80.0
06/07/04	8.0	6.4	121	77.0	21.25	<0.02	0.31	0.05	6	0.18	73.3
07/13/04	7.1	6.5	97	61.9	25.31	<0.02	0.20	0.07	6	0.32	80.0
08/10/04	6.5	6.3	117	74.9	22.18	<0.02	0.33	0.03	<5	0.41	80.0
09/13/04	8.7	6.3	114	72.8	20.96	0.02	0.27	0.11	<5	0.17	80.0
10/12/04	9.3	6.1	116	74.2	13.63	<0.02	0.31	0.08	<5	0.33	80.0
11/16/04	12.1	6.4	100	64.0	7.82	0.06	0.27	0.02	8	0.26	60.0
12/14/04	11.5	6.7	104	66.8	6.45	0.06	0.35	0.02	<5	0.25	73.3
Minimum	6.5	6.1	97	61.9	3.85	<0.02	0.20	0.02	<5	0.11	60.0
Median	**9.0**	**6.5**	**116**	**74.6**	**12.11**	**<0.02**	**0.32**	**0.05**	**<5**	**0.25**	**76.7**
Maximum	12.1	6.8	153	98.1	25.31	0.06	0.44	0.11	8	0.41	80.0
2003 Median	***8.7***	***6.4***	***118***	***75.5***	***13.32***	***<0.02***	***0.20***	***0.04***	***5***	***0.17***	***80.0***
2002 Median	***10.4***	***6.5***	***132***	***84.6***	***12.74***	***<0.03***	***0.12***	***0.06***	*****	***0.17***	*****

Pocoshock Creek is a perennial tributary of Falling Creek located in the Piedmont and Alluvium region of Chesterfield County. Its substrate is comprised mainly of sand, gravel and cobble, with scattered boulders present near the bridge. Pocoshock Creek exhibited sustained flows throughout the year. Clear water was observed during all surveys. The stream's banks are well vegetated with moderate areas of erosion present. Extremely high flows from Tropical Storm Gaston resulted in severe flooding at this site during late August.

Riparian vegetation consisted largely of hardwood trees and shrubs. Periphyton, algae and macroinvertebrates were observed at the site during 2004.

Samples were obtained from the left bank at a median depth of 0.05 meters. The annual median index score indicated moderate chemical water quality. All monthly physical parameters were within acceptable ranges during 2004. The stream's water was soft (annual median calcium hardness (20 mg/L $CaCO_3$) and well buffered (annual median alkalinity 30 mg/L $CaCO_3$). Turbidity values were generally low during 2004, never exceeding 8 FTUs. The annual median concentration of ammonia nitrogen was within expected limits. The annual median nitrate+nitrite nitrogen concentration was elevated (0.32 mg/L as N) and was greater than the annual medians of 2002 and 2003. Phosphate phosphorus values were comparable to observations from previous years.

Site Number WQ-17

Stream: Falling Creek

Site: 20 meters Downstream of the Old Buckingham Road Crossing, Midlothian, Virginia

Latitude: 37° 30' 28.50134"
Longitude: 77° 38' 00.65209"

Watershed: Falling Creek

Stream Order: 2

Landuse: Suburban Residential

Gradient: High

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/16/04	13.4	6.5	113	72.1	4.01	0.07	0.39	<0.01	8	0.21	66.7
02/26/04	10.4	6.5	124	79.2	4.25	0.05	0.55	0.02	10	0.18	53.3
03/08/04	8.0	6.3	122	78.1	10.01	0.14	0.44	<0.01	12	0.24	60.0
04/05/04	11.1	6.4	115	73.8	9.84	0.04	0.34	0.01	<5	0.24	86.7
05/18/04	6.8	6.5	160	101.8	21.17	0.13	0.35	0.04	12	0.22	53.3
06/08/04	7.8	6.3	144	91.9	21.47	0.05	0.25	0.06	10	0.22	60.0
07/14/04	6.9	6.3	127	81.4	25.04	0.07	0.18	0.05	10	0.20	66.7
08/09/04	7.6	6.5	134	86.2	21.37	0.07	0.35	0.02	12	0.17	53.3
09/14/04	6.9	6.4	115	74.3	21.36	0.03	0.27	0.02	14	0.32	60.0
10/11/04	9.4	6.3	154	98.7	15.26	0.05	0.32	0.03	12	0.26	53.3
11/15/04	10.4	6.9	89	56.5	11.53	0.64	0.13	0.02	20	0.64	46.7
12/13/04	11.2	6.8	88	56.5	10.06	0.63	0.23	0.01	18	0.30	46.7
Minimum	6.8	6.3	88	56.5	4.01	0.03	0.13	<0.01	<5	0.17	46.7
Median	**8.7**	**6.4**	**123**	**78.7**	**13.40**	**0.07**	**0.33**	**0.02**	**12**	**0.23**	**56.7**
Maximum	13.4	6.9	160	101.8	25.04	0.64	0.55	0.06	20	0.64	86.7
2003 Median	***8.3***	***6.2***	***125***	***80.0***	***14.80***	***0.06***	***0.18***	***0.01***	***11***	***0.28***	***66.7***
2002 Median	***9.7***	***6.2***	***149***	***95.9***	***10.67***	***<0.03***	***0.10***	***<0.01***	*****	***0.13***	*****

Falling Creek is a perennial tributary of the James River and is considered one of its major watersheds. This site near the headwaters of Falling Creek in the High River Terrace region of Chesterfield County is located approximately 14.3 miles upstream of the Falling Creek site WQ-08. Here Falling Creek exhibited sustained flows throughout the year with flows supplemented at times from flood control activities at Lake Salisbury. Its substrate is comprised of sand, gravel and cobble. Clear water was present during the majority of the surveys, with five instances of turbid or stained water observed during the year. The stream's banks are slightly vegetated with moderate areas of erosion present. The riparian area at this site is in the process of recovering from recent intense road and utilities construction in the immediate vicinity.

Riparian vegetation consisted primarily of trees and shrubs. Iron Bacteria, periphyton and algae were observed throughout the year.

Samples were obtained from the right bank at a median depth of 0.08 meters. The annual median index score indicated low chemical water quality, due in part to the elevated nutrient levels observed throughout the year. All monthly physical parameters were within acceptable ranges during 2004. The stream's water was soft (annual median calcium hardness (20 mg/L $CaCO_3$) and well buffered (annual median alkalinity 38 mg/L $CaCO_3$). Turbidity observations ranged from <5 to 20 FTUs during 2004. Annual median concentrations of ammonia and nitrate+nitrite nitrogen were elevated in 2004. Annual median phosphate phosphorus was greater than the 2002 and 2003 medians. Potential sources of nutrient inputs to the headwaters of Falling Creek may be the residential areas immediately upstream of the site as well as disturbances from the recent road and utilities improvements.

Site Number WQ-19

Stream: Nuttree Branch

Site: 20 meters Upstream of the Old Hundred Road Crossing, Midlothian, Virginia

Latitude: 37° 26' 01.76377"
Longitude: 77° 38' 35.88637"

Watershed: Swift Creek

Stream Order: 2

Landuse: Suburban Residential; Golf Course

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/16/04	13.9	6.6	94	59.7	5.16	0.02	0.13	<0.01	6	0.07	86.7
02/26/04	9.9	6.9	131	83.6	6.52	<0.02	0.08	0.01	10	0.06	86.7
03/08/04	8.0	6.5	133	84.8	12.71	0.05	0.18	0.03	20	0.16	60.0
04/06/04	11.0	7.0	122	78.4	13.60	<0.02	0.04	0.01	10	0.04	86.7
05/18/04	6.5	6.7	125	80.1	24.37	0.05	0.08	0.06	6	0.09	80.0
06/08/04	6.9	6.3	116	74.1	28.09	0.04	0.31	0.05	10	0.04	66.7
07/14/04	6.2	6.4	89	56.7	30.52	<0.02	0.04	0.06	12	0.08	73.3
08/09/04	7.1	6.4	89	57.2	26.50	0.05	0.12	0.03	22	0.03	60.0
09/14/04	5.8	6.3	80	51.4	23.82	0.09	0.13	0.05	<5	0.04	80.0
10/11/04	8.8	6.2	92	58.5	18.31	<0.02	0.12	0.03	<5	<0.01	86.7
11/15/04	9.6	6.6	76	48.8	10.21	0.06	0.20	<0.01	22	0.12	66.7
12/13/04	9.8	6.7	85	54.4	9.89	0.11	0.18	0.03	24	0.08	60.0
Minimum	5.8	6.2	76	48.8	5.16	<0.02	0.04	<0.01	<5	<0.01	60.0
Median	**8.4**	**6.6**	**93**	**59.1**	**15.96**	**0.05**	**0.13**	**0.03**	**10**	**0.07**	**76.7**
Maximum	13.9	7.0	133	84.8	30.52	0.11	0.31	0.06	24	0.16	86.7
2003 Median	***8.2***	***6.3***	***95***	***60.9***	***16.02***	***0.02***	***0.09***	***0.01***	***<5***	***0.10***	***80.0***
2002 Median	***9.9***	***6.2***	***106***	***67.9***	***10.42***	***<0.03***	***0.11***	***0.05***	*****	***0.12***	*****

Nuttree Branch is a perennial tributary of Swift Creek located in the Triassic Basin region of Chesterfield County. Its substrate is comprised mainly of sand, gravel, cobble and an occasional small boulder. Flows were present, although at times sluggish, at Nuttree Branch throughout the year. Clear water was observed on six occasions during 2004 with the remaining observation being categorized as stained or turbid. The banks of Nuttree Branch are well vegetated with slight areas of erosion present.

Riparian vegetation at the site consisted primarily of trees, shrubs, grasses and herbaceous growth. Periphyton, algae, emergent plants, submerged plants and macroinvertebrates were observed throughout the year. Fish were present in the late summer.

Samples were obtained from the right bank at a median depth of 0.05 meters. The annual median index score indicated moderate chemical water quality. All monthly physical parameters were within acceptable ranges during 2004. The stream's water was soft (annual median calcium hardness (13 mg/L $CaCO_3$) and very well buffered (annual median alkalinity 50 mg/L $CaCO_3$). Turbidity ranged from <5 to 24 FTUs. The annual median concentration of ammonia (0.05 mg/L as N) was higher than observed in prior years. The annual median nitrate+nitrite nitrogen concentration was slightly higher as well (0.13 mg/L as N). The annual median phosphate phosphorus concentration (0.03 mg/L as P) fell within the range of previously documented values.

Site Number WQ-20

Stream: Swift Creek

Site: 10 meters Upstream of the Bailey Bridge Road Crossing, Midlothian, Virginia

Latitude: 37° 24' 40.61230"
Longitude: 77° 37' 05.21801"

Watershed: Swift Creek

Stream Order: 4

Landuse: Residential; Route 288 Parallel to Creek; Sewage Pump Station Immediately Downstream

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/16/04	13.1	6.4	67	42.7	3.90	<0.02	0.27	0.01	12	0.23	66.7
02/26/04	9.9	6.8	76	48.8	5.09	<0.02	0.20	0.03	10	0.23	73.3
03/08/04	8.2	6.5	72	46.4	11.25	0.03	0.11	0.01	14	0.40	73.3
04/06/04	10.4	6.8	81	51.9	10.94	<0.02	0.09	0.02	10	0.19	80.0
05/18/04	5.0	6.6	162	103.7	22.07	0.19	0.44	0.07	<5	0.09	66.7
06/08/04	6.7	6.2	91	58.4	23.81	0.05	0.28	0.01	<5	0.19	80.0
07/14/04	5.3	6.2	85	54.3	28.66	0.05	0.20	0.05	<5	0.24	80.0
08/09/04	6.1	6.2	64	41.2	25.70	0.05	0.14	0.01	8	0.20	73.3
09/14/04	6.0	6.0	42	26.8	24.69	0.05	0.03	0.05	22	0.54	66.7
10/11/04	7.3	6.3	138	88.6	17.07	0.04	0.95	0.02	10	0.11	60.0
11/15/04	10.6	6.7	48	30.8	11.78	0.02	0.07	0.03	14	0.33	73.3
12/13/04	10.9	6.8	54	34.6	10.35	0.03	0.09	0.04	10	0.24	80.0
Minimum	5.0	6.0	42	26.8	3.90	<0.02	0.03	0.01	<5	0.09	60.0
Median	**7.8**	**6.4**	**74**	**47.6**	**14.43**	**0.04**	**0.17**	**0.03**	**10**	**0.23**	**73.3**
Maximum	13.1	6.8	162	103.7	28.66	0.19	0.95	0.07	22	0.54	80.0
2003 Median	***7.9***	***6.2***	***84***	***54.2***	***14.88***	***0.03***	***0.12***	***0.02***	***9***	***0.19***	***73.3***
2002 Median	***6.2***	***6.4***	***167***	***106.6***	***14.01***	***0.04***	***0.17***	***0.06***	*******	***<0.01***	*******

Swift Creek is a perennial tributary and major watershed of the Appomattox River that bisects the Piedmont and Alluvium region of Chesterfield County. This site is located approximately 13.5 miles upstream of the Swift Creek site WQ-03 and 1.6 miles downstream of the Swift Creek Reservoir. Its substrate is comprised primarily of silt and clay with scattered deposits of sand and gravel. Water coloration at this site was stained or turbid for the majority of 2003. Clear water was observed on five occasions. The stream's banks are well vegetated with slight areas of erosion present.

Riparian vegetation was comprised of small trees and shrubs with grasses and herbaceous growth present during the latter half of the year. Periphyton, algae, submerged plants and amphibians were prevalent throughout the year. Fish were observed during July and August.

Samples were obtained from the left bank at a median depth of 0.10 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were all within expected ranges during 2004. The stream's water was very soft (annual median calcium hardness (10 mg/L $CaCO_3$) and well buffered (annual median alkalinity 30 mg/L $CaCO_3$). Turbidity values generally fell in the moderate range. The annual median concentration of ammonia nitrogen was slightly elevated with high value (0.19 mg/L as N) noted in May. Annual median nitrate+nitrite nitrogen and phosphate phosphorus concentrations were acceptable and fell within the range of previous years observations.

Site Number WQ-21

Stream: Spring Run

Site: 25 meters Downstream of the Buck Rub Drive Crossing, Midlothian, Virginia

Latitude: 37° 24' 10.85264"
Longitude: 77° 38' 52.14516"

Watershed: Swift Creek

Stream Order: 2

Landuse: Suburban Residential

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/16/04	13.6	5.6	93	59.5	4.12	0.02	0.18	0.02	16	0.07	60.0
02/26/04	10.9	7.6	97	62.1	5.34	<0.02	0.07	0.02	14	0.09	73.3
03/08/04	8.4	6.8	88	56.5	11.83	0.03	0.20	0.04	22	0.20	66.7
04/06/04	12.1	7.1	101	64.5	11.10	<0.02	0.07	0.02	8	0.08	80.0
05/18/04	7.4	6.8	131	83.5	19.23	0.03	0.32	0.09	10	0.07	66.7
06/08/04	7.8	6.5	121	77.4	21.22	0.03	0.25	0.07	8	0.13	66.7
07/14/04	6.1	6.4	106	68.0	25.49	0.02	0.12	0.17	14	0.17	60.0
08/09/04	8.3	6.6	97	61.8	21.56	<0.02	0.18	0.05	16	0.11	66.7
09/14/04	6.6	6.5	93	59.8	21.44	0.04	0.14	0.02	24	0.08	66.7
10/11/04	8.7	6.4	105	67.3	15.78	<0.02	0.17	0.08	18	0.03	66.7
11/15/04	9.7	6.8	93	59.3	9.92	0.07	0.20	0.13	34	<0.01	60.0
12/13/04	9.7	7.0	97	62.3	10.25	0.02	0.24	0.06	20	0.04	60.0
Minimum	6.1	5.6	88	56.5	4.12	<0.02	0.07	0.02	8	<0.01	60.0
Median	**8.5**	**6.7**	**97**	**62.2**	**13.81**	**0.02**	**0.18**	**0.06**	**16**	**0.08**	**66.7**
Maximum	13.6	7.6	131	83.5	25.49	0.07	0.32	0.17	34	0.20	80.0
2003 Median	***8.1***	***6.6***	***106***	***68.1***	***15.78***	***0.02***	***0.12***	***0.05***	***15***	***0.14***	***73.3***
2002 Median	***9.4***	***6.6***	***150***	***95.5***	***12.70***	***<0.03***	***0.15***	***0.07***	*****	***0.15***	*****

Spring Run is a perennial tributary of Swift Creek located in the Piedmont and Alluvium region of Chesterfield County. Its substrate is comprised of sand and gravel. Spring Run exhibited flow throughout all of 2004 with low flows from instream obstructions observed in November. The water was stained, milky or turbid for the majority of the surveys with clear water noted on only four surveys. The stream's banks are vegetated with areas of moderate erosion present.

Dominant riparian vegetation consisted of hardwood trees and shrubs, with grasses present during March and November. Instream flora included Iron bacteria and periphyton. Macroinvertebrates were observed on occasion during the year.

Samples were obtained from the left bank at a median depth of 0.05 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were all within normal expected ranges during 2004. There was one instance of low pH (5.6 units) observed in January. The stream's water was soft (annual median calcium hardness (18 mg/L $CaCO_3$) and well buffered (annual median alkalinity 58 mg/L $CaCO_3$). Turbidity levels were moderately high and ranged from 8 to 34 FTUs. The annual median concentrations of ammonia and nitrate+nitrite nitrogen were acceptable. The annual median phosphate phosphorus concentration was elevated (0.06 mg/L as P) and was similar to the values observed in 2002 and 2003. These consistently high levels are most likely attributed to the dense residential development within Spring Run's watershed.

Site Number WQ-22

Stream: Third Branch

Site: 50 meters Downstream of the Spring Run Road Bridge Crossing, Chesterfield, Virginia

Latitude: 37° 22' 18.12083"
Longitude: 77° 35' 57.07284"

Watershed: Swift Creek

Stream Order: 3

Landuse: Rural Residential; Forested; Site Located in Pocohontas State Park

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/16/04	13.6	6.3	46	29.3	2.48	<0.02	0.17	<0.01	<5	0.25	93.3
02/25/04	10.9	5.8	46	29.4	4.26	<0.02	0.13	0.12	<5	0.25	80.0
03/08/04	8.1	6.4	48	30.9	10.04	0.02	0.08	0.02	18	0.30	73.3
04/06/04	12.3	6.6	50	31.8	9.65	<0.02	0.09	0.02	<5	0.28	93.3
05/17/04	7.9	6.5	66	42.1	18.81	0.01	0.24	0.04	6	0.24	73.3
06/07/04	9.1	6.3	67	42.9	18.44	0.06	0.20	<0.01	8	0.24	73.3
07/13/04	7.2	6.4	58	36.9	22.73	<0.02	0.14	0.10	10	0.27	73.3
08/09/04	8.6	6.3	49	31.3	20.32	0.04	0.08	0.05	38	0.31	73.3
09/13/04	9.8	6.0	47	30.2	20.35	<0.02	0.09	0.11	10	0.42	80.0
10/11/04	9.1	6.2	54	34.6	14.77	<0.02	0.13	0.03	10	0.21	73.3
11/15/04	11.5	6.5	45	28.6	8.52	<0.02	0.10	0.01	8	0.29	86.7
12/13/04	11.2	6.6	47	29.9	9.12	<0.02	0.11	0.09	<5	0.24	86.7
Minimum	7.2	5.8	45	28.6	2.48	<0.02	0.08	<0.01	<5	0.21	73.3
Median	**9.5**	**6.4**	**49**	**31.1**	**12.41**	**<0.02**	**0.12**	**0.04**	**8**	**0.26**	**76.7**
Maximum	13.6	6.6	67	42.9	22.73	0.06	0.24	0.12	38	0.42	93.3
2003 Median	***8.9***	***6.1***	***56***	***35.6***	***14.70***	***<0.02***	***0.08***	***0.02***	***<5***	***0.11***	***86.7***
2002 Median	***10.2***	***6.0***	***69***	***44.0***	***10.91***	***<0.03***	***0.06***	***0.05***	*****	***0.05***	*****

Third Branch is a perennial tributary of Swift Creek located in the Piedmont and Alluvium region of Chesterfield County. Its substrate is comprised largely of sand and gravel with cobble and small boulders located at the Spring Run Road Bridge. Moderate flows were noted throughout the year. Clear water was observed on eleven occasions during 2004 with only one turbid condition noted in August. The stream's banks remained well vegetated with moderate to heavy areas of erosion present.

Riparian vegetation was dominated by hardwood trees and shrubs. Instream flora consisted largely of periphyton and algae. Macroinvertebrates were also observed at times during the year.

Samples were obtained from the left bank at a median depth of 0.05 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were within normal expected ranges during 2004. There was only one instance where the instream pH value (February, 5.8 units) failed to meet the state water quality standard. The stream's water was extremely soft (annual median calcium hardness (<10 mg/L $CaCO_3$) and well buffered (annual median alkalinity 28 mg/L $CaCO_3$). Turbidity values were typically low (<5 – 10 FTUs) with the highest observation noted in August (38 FTUs). Annual median concentrations of ammonia and nitrate+nitrite nitrogen were within acceptable limits and were similar to previous annual medians. The annual median phosphate phosphorus concentration (0.04 mg/L as P) was likewise similar to previous year's observations.

Site Number WQ-24

Stream: Cattle Creek

Site: 15 meters Upstream of the Ivey Mill Road Crossing, Chesterfield, Virginia

Latitude: 37° 17' 09.93978"
Longitude: 77° 37' 11.00699"

Watershed: Appomattox River

Stream Order: 2

Landuse: Rural Residential; Forested

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/16/04	13.3	6.3	44	28.4	2.83	<0.02	0.07	0.02	6	0.43	86.7
02/26/04	9.4	6.0	44	28.2	4.28	<0.02	0.03	0.08	8	0.25	80.0
03/08/04	7.4	6.2	48	30.4	10.08	0.04	0.02	0.03	12	0.25	73.3
04/06/04	11.5	6.2	49	31.3	7.79	0.02	<0.02	0.02	8	0.27	80.0
05/17/04	7.1	6.6	60	38.7	20.59	0.05	0.06	0.06	12	0.14	66.7
06/08/04	7.7	6.2	56	35.9	20.49	0.03	0.05	0.09	6	0.26	86.7
07/14/04	6.2	6.2	60	38.5	24.68	0.03	<0.02	0.08	12	0.31	73.3
08/09/04	7.0	6.0	47	29.9	21.08	0.02	<0.02	0.03	22	0.48	73.3
09/14/04	6.3	5.9	49	31.1	20.37	<0.02	<0.02	0.08	16	0.61	66.7
10/11/04	8.6	5.8	55	35.3	13.26	0.03	0.05	0.03	14	0.52	66.7
11/15/04	11.9	6.1	43	27.8	6.43	0.05	0.06	0.04	10	0.38	73.3
12/13/04	11.1	6.5	44	28.2	8.58	0.06	0.06	0.08	10	0.36	73.3
Minimum	6.2	5.8	43	27.8	2.83	<0.02	<0.02	0.02	6	0.14	66.7
Median	**8.1**	**6.2**	**48**	**30.8**	**11.67**	**0.03**	**0.04**	**0.05**	**11**	**0.34**	**73.3**
Maximum	13.3	6.6	60	38.7	24.68	0.06	0.07	0.09	22	0.61	86.7
2003 Median	***8.7***	***6.0***	***50***	***32.2***	***13.30***	***<0.02***	***0.02***	***0.05***	***10***	***0.42***	***80.0***
2002 Median	***8.4***	***6.3***	***67***	***43.0***	***13.77***	***<0.03***	***0.06***	***0.13***	*****	***0.25***	*****

Cattle Creek is a perennial tributary of the Appomattox River located in the Piedmont region of Chesterfield County. The stream's substrate is comprised of sand and gravel. Cattle Creek exhibited strong flows throughout the year with clear water observed during each month. The stream's banks are well vegetated with only slight areas of scattered erosion present.

Dominant riparian vegetation consisted of hardwood trees and shrubs. As in past years, there was an abundance of biota at Cattle Creek. Instream flora included iron bacteria, periphyton, algae and submerged plants. Macroinvertebrates were also prevalent during the year. In 2002, Cattle Creek was the only stream of its size monitored which had a large population of freshwater mussels present. This population of mussels appeared to have disappeared as they were not observed widely in 2003 nor were they present in 2004.

Samples were obtained from the left bank at a median depth of 0.02 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were mostly within expected ranges during 2004; however, there were two instances where pH values failed to meet the state water quality standard. The stream's water was extremely soft (annual median calcium hardness (<10 mg/L $CaCO_3$) and well buffered (annual median alkalinity 40 mg/L $CaCO_3$). Annual median turbidity was 11 FTUs with the majority of the monthly values falling within the moderate range. Annual median concentrations of ammonia and nitrate+nitrite nitrogen were very low. The annual median phosphate phosphorus concentration for 2004 (0.05 mg/L as P) was the same as observed in 2003. This phosphorus concentration is greater than expected for a rural watershed.

Site Number WQ-25

Stream: Winterpock Creek

Site: At the Winterpock Road Bridge Crossing, Winterpock, Virginia

Latitude: 37° 20' 44.70740"
Longitude: 77° 43' 12.04342"

Watershed: Appomattox River

Stream Order: 2

Landuse: Rural Residential; Forested

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
01/16/04	13.1	5.6	47	30.6	1.71	<0.02	0.04	0.01	6	0.04	86.7
02/26/04	8.5	6.2	5	34.0	4.09	<0.02	0.02	0.02	6	0.06	86.7
03/08/04	6.7	5.9	53	33.9	10.50	<0.02	0.38	0.01	10	0.10	66.7
04/06/04	8.7	6.2	60	38.2	7.95	<0.02	<0.02	0.01	10	<0.01	86.7
05/18/04	2.4	6.4	77	48.8	19.89	0.18	0.04	0.10	10	<0.01	60.0
06/08/04	1.9	5.9	86	55.0	18.94	0.09	0.06	0.19	<5	<0.01	66.7
07/14/04	5.0	5.8	51	32.3	24.97	0.04	<0.02	0.02	24	0.09	66.7
08/09/04	5.6	5.9	53	33.9	21.35	0.05	0.03	0.01	<5	<0.01	86.7
09/14/04	5.6	5.9	51	33.1	21.29	0.04	0.02	0.06	12	<0.01	66.7
10/11/04	5.8	5.8	64	41.0	15.11	<0.02	0.06	0.06	10	<0.01	73.3
11/15/04	10.2	6.1	50	32.1	5.96	<0.02	0.04	<0.01	<5	0.09	100.0
12/13/04	10.0	6.2	48	30.4	7.67	<0.02	0.02	0.01	<5	0.10	100.0
Minimum	1.9	5.6	5	30.4	1.71	<0.02	<0.02	<0.01	<5	<0.01	60.0
Median	**6.2**	**5.9**	**52**	**33.9**	**12.81**	**<0.02**	**0.04**	**0.02**	**8**	**0.02**	**80.0**
Maximum	13.1	6.4	86	55.0	24.97	0.18	0.38	0.19	24	0.10	100.0
2003 Median	***6.4***	***5.6***	***58***	***37.2***	***12.70***	***<0.02***	***0.02***	***0.01***	***10***	***0.01***	***80.0***
2002 Median	***4.4***	***5.9***	***118***	***75.8***	***14.82***	***0.06***	***0.04***	***0.03***	*******	***<0.01***	*******

Winterpock Creek is a perennial tributary of the Appomattox River located in the Triassic Basin region of Chesterfield County. The stream's substrate is comprised of silt, clay and sand. Flows at Winterpock Creek remained largely sluggish during the year due to beaver activity downstream. Stained water was observed on all surveys. The stream's banks are well vegetated with no areas of visible erosion present.

Dominant riparian vegetation consisted of hardwood trees and shrubs with herbaceous growth present during the warmer months. Instream biota consisted largely of bacterial sheens, iron bacteria and periphyton.

Samples were obtained from the left bank at a median depth of 0.10 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were mostly within normal expected ranges during 2004. Dissolved oxygen concentration failed to meet the state water quality standards during May and June and low pH values were observed during several months of the year. The low pH observed in Winterpock Creek since 2002 more than likely represents the natural condition for this stream. The stream's water was very soft (annual median calcium hardness 10 mg/L $CaCO_3$) and very well buffered (annual median alkalinity 45 mg/L $CaCO_3$). Annual median turbidity was 8 FTUs, with the majority of the monthly values falling within the low to moderate range. Annual median concentrations of ammonia and nitrate+nitrite nitrogen were very low. The annual median phosphate phosphorus concentration (0.02 mg/L as P) was within the range of previously reported values. Despite the moderate chemical water quality observed in Winterpock Creek, it still remains on the VADEQ's impaired waters list for pH.

Site Number WQ-27

Stream: Turkey Creek

Site: Immediately Upstream of the Mount Hermon Road Bridge Crossing, Moseley, Virginia

Latitude: 37° 28' 00.42812"
Longitude: 77° 44' 33.91912"

Watershed: Upper Swift Creek

Stream Order: 3

Landuse: Pasture, Rural Residential; Forested

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
02/26/04	10.1	6.4	50	32.2	2.27	<0.02	<0.02	0.06	<5	0.13	93.3
03/08/04	8.1	6.1	50	31.7	8.22	<0.02	<0.02	<0.01	6	0.08	93.3
04/06/04	12.0	6.3	51	32.7	6.22	<0.02	<0.02	<0.01	<5	0.06	100.0
05/18/04	8.0	6.3	48	31.0	18.71	0.02	0.07	0.02	6	0.06	86.7
06/08/04	8.1	6.3	61	39.3	18.78	<0.02	0.10	<0.01	<5	0.07	100.0
07/14/04	7.2	6.3	64	41.3	22.90	<0.02	0.08	0.05	16	0.04	73.3
08/09/04	8.0	6.2	49	31.0	19.28	<0.02	0.04	0.01	<5	0.04	100.0
09/14/04	7.5	6.1	47	29.9	19.43	<0.02	0.03	0.08	<5	0.04	93.3
10/11/04	8.3	6.0	57	36.3	13.28	<0.02	0.02	0.01	<5	0.04	100.0
11/15/04	12.5	6.4	47	29.9	6.31	<0.02	0.04	0.02	<5	0.10	93.3
12/13/04	11.5	6.6	45	28.8	8.39	<0.02	0.06	0.02	<5	0.09	93.3
Minimum	7.2	6.0	45	28.8	2.27	<0.02	<0.02	<0.01	<5	0.04	73.3
Median	**8.1**	**6.3**	**50**	**31.7**	**13.28**	**<0.02**	**0.04**	**0.02**	**<5**	**0.06**	**93.3**
Maximum	12.5	6.6	64	41.3	22.90	0.02	0.10	0.08	16	0.13	100.0

This monthly sampling site at Turkey Creek was established in February of 2004. Turkey Creek is a perennial tributary of Swift Creek located in the Triassic Basin region of Chesterfield County. Its substrate is largely comprised of sand and gravel with cobble, small boulders and an outcrop of bedrock immediately downstream of the sampling site. Turkey Creek exhibited flow throughout all of 2004 with low flow conditions observed in November. With the exception of one turbid observation in July, clear water was noted on all surveys. The stream's banks are vegetated with areas of slight to moderate erosion present.

Dominant riparian vegetation consisted of hardwood trees and shrubs. Periphyton, algae and macroinvertebrates were observed at the site during 2004. Fish were noted in June.

Samples were obtained from the left bank at a median depth of 0.05 meters. Turkey Creek exhibited the best conditions in the 2004 data set with the annual median index score indicating high chemical water quality. Physical parameters were all within normal expected ranges during 2004. The stream's water was extremely soft (annual median calcium hardness (<10 mg/L $CaCO_3$) and exhibited low buffering capacity (annual median alkalinity 15 mg/L $CaCO_3$). Turbidity levels were consistently low ranging from <5 to 16 FTUs. The annual median concentrations of ammonia and nitrate+nitrite nitrogen were acceptable. Phosphate phosphorus concentrations were generally acceptable throughout the year. The low nutrient levels observed at Turkey Creek during 2004 reflect the more rural nature of this watershed.

Site Number WQ-28

Stream: Ashton Creek

Site: Immediately Downstream of the Ruffin Mill Road Bridge Crossing, Colonial Heights, Virginia

Latitude: 37° 18' 57.34548"
Longitude: 77° 22' 23.45574"

Watershed: Appomattox River

Stream Order: 3

Landuse: Residential; Forested; Wastewater Pump Station

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
02/25/04	9.8	6.3	124	79.2	5.42	0.03	0.55	<0.01	10	0.13	66.7
03/09/04	9.1	6.3	151	97.1	8.28	0.05	0.35	<0.01	10	0.17	66.7
04/05/04	11.0	6.2	109	69.7	9.25	0.04	0.40	0.02	8	0.17	66.7
05/17/04	7.6	6.8	110	70.0	23.45	0.02	0.27	0.04	<5	0.18	80.0
06/07/04	8.1	6.3	104	67.1	22.60	0.11	0.24	<0.01	10	0.18	66.7
07/13/04	7.0	6.4	91	57.8	27.15	0.04	0.08	0.05	10	0.24	80.0
08/10/04	6.2	6.1	88	56.6	23.13	0.03	0.11	0.03	10	0.43	73.3
09/13/04	8.6	5.9	82	53.3	22.70	0.02	0.11	0.05	12	0.32	60.0
10/12/04	8.7	6.1	86	54.3	15.34	0.04	0.24	0.01	6	0.29	80.0
11/16/04	12.3	6.7	89	57.3	8.26	0.05	0.24	0.05	8	0.20	60.0
12/14/04	11.7	6.6	88	56.1	6.37	0.10	0.36	0.05	10	0.19	60.0
Minimum	6.2	5.9	82	53.3	5.42	0.02	0.08	<0.01	<5	0.13	60.0
Median	**8.7**	**6.3**	**91**	**57.8**	**15.34**	**0.04**	**0.24**	**0.03**	**10**	**0.19**	**66.7**
Maximum	12.3	6.8	151	97.1	27.15	0.11	0.55	0.05	12	0.43	80.0

The monthly sampling site at Ashton Creek was established in February of 2004. Ashton Creek is a perennial tributary of the Appomattox River and lies in the Low River Terrace and Alluvium region of Chesterfield County. The stream's substrate is comprised of sand and gravel. Ashton Creek exhibited good flow at each survey month with an even mix of clear and stained water observed during the year. The stream's banks are well vegetated with only slight to moderate areas of erosion present.

Dominant riparian vegetation consisted of hardwood trees and shrubs. Instream flora observed included periphyton, algae and emergent plants. Macroinvertebrates were also noted during April and June.

Samples were obtained from the right bank at a median depth of 0.10 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were within normal expected ranges during 2004. There was only one instance where the instream pH value (September, 5.9 units) failed to meet the state water quality standard. The stream's water was soft (annual median calcium hardness (10 mg/L $CaCO_3$) and well buffered (annual median alkalinity 28 mg/L $CaCO_3$). Turbidity values were typically low (<5 – 12 FTUs). Annual median concentrations of ammonia and nitrate+nitrite nitrogen were slightly elevated but not excessive. The annual median phosphate phosphorus concentration (0.03 mg/L as P) was likewise slightly elevated.

Site Number WQ-29

Stream: Spring Creek

Site: Immediately Downstream of the Old Gun Road Bridge Crossing, Midlothian, Virginia

Latitude: 37° 33' 17.45762"
Longitude: 77° 36' 46.72803"

Watershed: James River

Stream Order: 1

Landuse: Residential; Field; Wetland

Gradient: Low

View is downstream of bridge

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
02/26/04	8.8	6.9	77	49.3	6.06	<0.02	0.51	0.03	<5	0.17	73.3
03/08/04	7.2	6.7	79	50.3	13.38	0.03	0.28	0.02	10	0.10	66.7
04/06/04	10.3	6.9	79	50.5	12.11	0.02	0.26	0.01	10	0.12	73.3
05/18/04	7.2	6.8	89	57.2	24.22	0.06	0.21	0.07	8	0.09	66.7
06/08/04	7.5	6.5	91	58.3	23.68	0.03	0.24	0.03	10	0.18	66.7
07/14/04	6.6	6.4	82	52.6	27.22	0.04	0.17	0.07	6	0.15	80.0
08/09/04	6.9	6.6	85	54.7	23.80	0.03	0.21	0.02	<5	0.15	86.7
09/14/04	5.8	6.4	81	52.1	22.36	0.11	0.12	0.05	10	0.06	66.7
10/11/04	7.8	6.3	89	56.8	16.01	0.07	0.27	0.05	8	0.04	60.0
11/15/04	10.8	6.9	79	50.6	9.68	0.10	0.25	0.08	10	0.26	60.0
12/13/04	11.6	6.9	81	51.9	9.19	0.12	0.32	0.08	8	0.32	60.0
Minimum	5.8	6.3	77	49.3	6.06	<0.02	0.12	0.01	<5	0.04	60.0
Median	**7.5**	**6.7**	**81**	**52.1**	**16.01**	**0.04**	**0.25**	**0.05**	**8**	**0.15**	**66.7**
Maximum	11.6	6.9	91	58.3	27.22	0.12	0.51	0.08	10	0.32	86.7

The monthly sampling site at Spring Creek was established in February of 2004. Spring Creek is a perennial tributary of the James River and lies in the Low River Terrace and Alluvium region of Chesterfield County. The stream's substrate is comprised of sand and gravel with cobble present near the road crossing. Spring Creek exhibited sustained flows throughout the year and clear water was observed during all surveys**.** The stream's banks are sparsely vegetated with moderate to heavy areas of erosion present.

Dominant riparian vegetation consisted of hardwood trees, shrubs and grasses/herbaceous growth. Instream flora observed included iron bacteria and periphyton. Fish were noted on several occasions. A brown water snake was observed sunning itself on the rocks near road crossing in June.

Samples were obtained from the right bank at a median depth of 0.05 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were within normal expected ranges during 2004. The stream's water was soft (annual median calcium hardness (13 mg/L $CaCO_3$) and well buffered (annual median alkalinity 30 mg/L $CaCO_3$). Turbidity values were typically low, never exceeding 10 FTUs. Annual median concentrations of ammonia (0.04 mg/L as N) and nitrate+nitrite nitrogen (0.25 mg/L as N) were slightly elevated but not excessive. The annual median phosphate phosphorus concentration (0.05 mg/L as P) was likewise slightly elevated.

Site Number WQ-30

Stream: Tributary to Michaux Creek

Site: 75 meters Upstream of the Lastingham Drive Bridge Crossing, Midlothian, Virginia

Latitude: 37° 31' 21.96767"
Longitude: 77° 41' 01.015474"

Watershed: James River

Stream Order: 1

Landuse: Residential

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
02/25/04	9.4	6.8	72	46.3	4.81	<0.02	0.65	<0.01	<5	0.18	80.0
03/08/04	8.1	6.5	79	50.3	9.81	<0.02	0.44	0.01	<5	0.22	86.7
04/06/04	11.6	6.7	77	48.9	8.50	<0.02	0.42	<0.01	<5	0.11	86.7
05/18/04	8.7	6.8	86	55.2	19.21	<0.02	0.51	0.03	8	0.15	60.0
06/08/04	8.9	6.6	91	57.9	19.54	<0.02	0.35	0.01	<5	0.11	86.7
07/14/04	8.2	6.6	92	58.6	22.42	<0.02	0.25	0.08	6	0.06	73.3
08/09/04	9.0	6.8	88	56.1	20.16	<0.02	0.27	<0.01	<5	0.11	86.7
09/14/04	7.7	6.5	79	50.7	20.04	<0.02	0.70	0.04	<5	0.33	73.3
10/11/04	9.8	6.5	84	53.9	14.28	<0.02	0.32	<0.01	<5	0.17	86.7
11/15/04	11.4	6.9	80	51.2	9.66	<0.02	0.65	<0.01	<5	0.20	80.0
12/13/04	13.5	6.9	80	50.9	10.65	<0.02	0.85	<0.01	<5	0.18	80.0
Minimum	7.7	6.5	72	46.3	4.81	<0.02	0.25	<0.01	<5	0.06	60.0
Median	**9.0**	**6.7**	**80**	**51.2**	**14.28**	**<0.02**	**0.44**	**<0.01**	**<5**	**0.17**	**80.0**
Maximum	13.5	6.9	92	58.6	22.42	<0.02	0.85	0.08	8	0.33	86.7

The monthly sampling site at this un-named tributary to Michaux Creek was established in February of 2004. This stream is a perennial tributary of Michaux Creek and the James River and lies in the Triassic Basin region of Chesterfield County. The stream's substrate is comprised of sand, gravel and cobble. This site exhibited sustained flows throughout the year and clear water was observed during all surveys**.** The stream's banks are not well vegetated with moderate to heavy areas of erosion present. Roots and bank undercuts are prevalent.

Dominant riparian vegetation consisted of hardwood trees, shrubs and grasses/herbaceous growth. Instream flora observed included periphyton and algae. Macroinvertebrates and fish were noted on several occasions

Samples were obtained from the right bank at a median depth of 0.05 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were within normal expected ranges during 2004. The stream's water was soft (annual median calcium hardness (15 mg/L $CaCO_3$) and exhibited low buffering capacity (annual median alkalinity 15 mg/L $CaCO_3$). Turbidity values were typically low, never exceeding 8 FTUs. Annual median concentrations of ammonia (<0.02 mg/L as N) and phosphate phosphorus (<0.01 mg/L as P) were among the lowest observed during 2004. Nitrate+nitrite nitrogen was high throughout the year ranging from 0.25 mg/L as N to 0.85 mg/L as N and was greatest in the spring and autumn. These consistently high levels may be attributed to the dense residential development upstream of this site.

Site Number WQ-31

Stream: Pocoshock Creek

Site: 30 meters off the end of Pocono Drive Cul-de-Sac, Richmond, Virginia

Latitude: 37° 29' 44.56495"
Longitude: 77° 35' 12.83501"

Watershed: Falling Creek

Stream Order: 1

Landuse: Residential; Commercial; Forest

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
02/26/04	10.5	7.1	142	90.9	4.83	<0.02	0.47	0.07	6	0.05	66.7
03/08/04	7.9	6.7	146	93.6	11.27	0.02	0.33	<0.01	6	0.22	80.0
04/05/04	11.4	6.8	124	79.2	10.15	<0.02	0.32	0.01	<5	0.17	86.7
05/18/04	6.2	6.8	124	79.4	20.52	0.02	0.32	0.05	<5	0.12	80.0
06/08/04	7.4	6.4	121	77.5	20.65	<0.02	0.31	<0.01	<5	0.14	86.7
07/14/04	6.7	6.3	109	69.4	24.34	<0.02	0.24	0.08	<5		80.0
08/09/04	7.5	6.6	116	74.0	21.67	0.02	0.26	0.01	<5	0.16	86.7
09/14/04	6.6	6.6	127	81.3	20.87	<0.02	0.25	0.03	6	0.07	73.3
10/11/04	8.8	6.5	123	78.6	14.95	<0.02	0.35	<0.01	8	0.08	73.3
11/15/04	10.2	6.9	87	55.9	10.27	0.08	0.24	0.01	<5	0.25	80.0
12/13/04	10.8	6.9	100	64.2	10.09	0.02	0.41	0.05	8	0.24	66.7
Minimum	6.2	6.3	87	55.9	4.83	<0.02	0.24	<0.01	<5	0.05	66.7
Median	**7.9**	**6.7**	**123**	**78.6**	**14.95**	**<0.02**	**0.32**	**0.01**	**<5**	**0.15**	**80.0**
Maximum	11.4	7.1	146	93.6	24.34	0.08	0.47	0.08	8	0.25	86.7

The monthly sampling site at Pocoshock Creek was established in February of 2004. Pocoshock Creek is a perennial tributary of Falling Creek and lies in the Piedmont region of Chesterfield County. The site is located approximately 4.8 miles upstream of the Pocoshock Creek site at Turner Road (WQ-14). The stream's substrate is largely comprised of cobble with interspersed sand and gravel. Pocoshock Creek exhibited sustained flows throughout the year and clear water was observed during all surveys**.** The stream's banks are not well vegetated and are heavily eroded. Extremely high flows from Tropical Storm Gaston resulted in shifting of the stream channel downstream of the monitoring site and bank failure at several locations within 100 meters of the sampling site. A restoration plan is currently being planned for this stream.

Dominant riparian vegetation consisted of hardwood trees and shrubs. Instream flora observed included iron bacteria and periphyton. Fish were noted on several occasions. A fish nest constructed of small stones was present immediately upstream of the site during May.

Samples were obtained from the right bank at a median depth of 0.05 meters. The annual median index score indicated moderate chemical water quality. Physical parameters were within normal expected ranges during 2004. The stream's water was soft (annual median calcium hardness (20 mg/L $CaCO_3$) and well buffered (annual median alkalinity 23 mg/L $CaCO_3$). Turbidity values were typically low, never exceeding 8 FTUs. Annual median concentrations of ammonia (<0.02 mg/L as N) and phosphate phosphorus (0.01 mg/L as P) were low during 2004. Nitrate+nitrite nitrogen was high throughout the year ranging from 0.24 mg/L as N to 0.47 mg/L as N and may be attributed to the dense residential and commercial development upstream of this site.

Site Number WQ-32

Stream: Proctors Creek

Site: 20 meters Downstream of Salem Church Road, Richmond, Virginia

Latitude: 37° 23' 33.57825"
Longitude: 77° 29' 01.130042"

Watershed: Proctors Creek

Stream Order: 1

Landuse: Residential; Forest; Route 288

Gradient: Low

Field and Laboratory Observations:

Date	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Flow m/s	Index Score %Comparision
02/26/04	9.6	6.1	84	53.6	5.00	<0.02	0.85	<0.01	8	0.26	66.7
03/09/04	8.1	5.9	101	64.9	8.03	0.03	0.02	<0.01	16	0.32	73.3
04/05/04	11.2	6.0	81	51.9	8.90	0.04	0.43	<0.01	12	0.12	66.7
05/17/04	7.6	6.3	102	65.3	19.13	0.10	0.43	0.05	12	0.05	53.3
06/07/04	8.7	6.1	11	70.7	19.25	0.06	0.39	<0.01	16	0.10	60.0
07/13/04	7.2	6.2	97	61.8	23.54	0.07	0.28	0.13	14	0.06	53.3
08/10/04	6.2	5.8	79	50.4	21.15	0.03	0.90	0.05	18	0.15	46.7
09/13/04	8.5	5.5	68	43.3	20.64	<0.02	0.50	0.10	16	0.33	46.7
10/12/04	8.5	5.8	77	49.2	14.98	<0.02	0.60	0.02	10	0.12	53.3
11/16/04	11.2	6.2	66	42.3	9.59	<0.02	0.48	0.02	8	0.35	60.0
12/14/04	11.0	5.8	65	41.9	7.74	<0.02	0.60	0.04	10	0.22	53.3
Minimum	6.2	5.5	11	41.9	5.00	<0.02	0.02	<0.01	8	0.05	46.7
Median	**8.5**	**6.0**	**79**	**51.9**	**14.98**	**0.03**	**0.48**	**0.02**	**12**	**0.15**	**53.3**
Maximum	11.2	6.3	102	70.7	23.54	0.10	0.90	0.13	18	0.35	73.3

This monthly sampling site at Proctors Creek was established in February of 2004. Proctors Creek is a perennial tributary of Falling Creek and lies in the Deep Coastal Plain region of Chesterfield County. The site is located approximately 4.1 miles upstream of the Proctors Creek site at Jefferson Davis Highway (WQ-06). The stream's substrate is comprised of sand and gravel. Proctors Creek exhibited sustained flows throughout the year and clear water was observed on nine occasions**.** The stream's banks are vegetated and exhibit moderate to heavy erosion.

Dominant riparian vegetation consisted of hardwood trees and shrubs. Instream flora observed included periphyton and algae.

Samples were obtained from the right bank at a median depth of 0.05 meters. The annual median index score indicated low chemical water quality due to part to high nutrients and low pH. Physical parameters were mostly within normal expected ranges during 2004. There were several instances where the instream pH value failed to meet the state water quality standard. The stream's water was very soft (annual median calcium hardness (10 mg/L $CaCO_3$) and well buffered (annual median alkalinity 23 mg/L $CaCO_3$). Turbidity values were in the moderate range with high values never exceeding 18 FTUs. Annual median concentrations of ammonia (0.03 mg/L as N) and nitrate+nitrite nitrogen (0.48 mg/L as N) were elevated. The annual median phosphate phosphorus concentration (0.02 mg/L as P) was slightly elevated but not exceedingly so. The increased nutrient concentrations are typical for residential watersheds in Chesterfield County.

Discussion:

A review of the annual median chemical water quality index values demonstrated that the majority of the streams monitored in 2004 could be characterized as streams with moderate or high water quality (Table 2). Low water quality was observed at three of the monitored sites (Table 2).

Table 2. Annual chemical water quality categorical observations for 20 streams of Chesterfield County, 2004.

Site Number	Stream	Annual Median Score	Category
WQ-03	Swift Creek	**80.0**	**Moderate Quality**
WQ-05	Redwater Creek	**60.0**	**Low Quality**
WQ-06	Proctors Creek	**63.3**	**Moderate Quality**
WQ-07	Kingsland Creek	**66.7**	**Moderate Quality**
WQ-08	Falling Creek	**76.7**	**Moderate Quality**
WQ-10	Franks Branch	**76.7**	**Moderate Quality**
WQ-14	Pocoshock Creek	**76.7**	**Moderate Quality**
WQ-17	Falling Creek	**56.7**	**Low Quality**
WQ-19	Nuttree Branch	**76.7**	**Moderate Quality**
WQ-20	Swift Creek	**73.3**	**Moderate Quality**
WQ-21	Spring Run	**66.7**	**Moderate Quality**
WQ-22	Third Branch	**76.7**	**Moderate Quality**
WQ-24	Cattle Creek	**73.3**	**Moderate Quality**
WQ-25	Winterpock Creek	**80.0**	**Moderate Quality**
WQ-27	Turkey Creek	**93.3**	**High Quality**
WQ-28	Ashton Creek	**66.7**	**Moderate Quality**
WQ-29	Spring Creek	**66.7**	**Moderate Quality**
WQ-30	Trib To Michaux Creek	**80.0**	**Moderate Quality**
WQ-31	Pocoshock Creek	**80.0**	**Moderate Quality**
WQ-32	Proctors Creek	**53.3**	**Low Quality**

High water quality was observed at Turkey Creek (WQ-27) during 2004. Distinguishing characteristics of this stream included well oxygenated water, absent periods of low pH, low concentrations of nutrients and low levels of turbidity. Additionally, other physical and chemical parameters were either all indicative of good water quality or were not substantially degraded on a monthly basis. Turkey Creek flows through a relatively undeveloped area and is not subjected to non-point source pollution to the degree of some of the more suburban and urban sites.

Low water quality was observed at Redwater Creek (WQ-05), Falling Creek (WQ-17) and Proctors Creek (WQ-32) during 2004. These streams flow through relatively densely populated areas and are more impacted by runoff. The distinguishing characteristic of these streams included frequent elevated concentrations of nitrogen, phosphorus and turbidity. The

remainder of the monitored sites possessed annual median index scores indicative of moderate water quality.

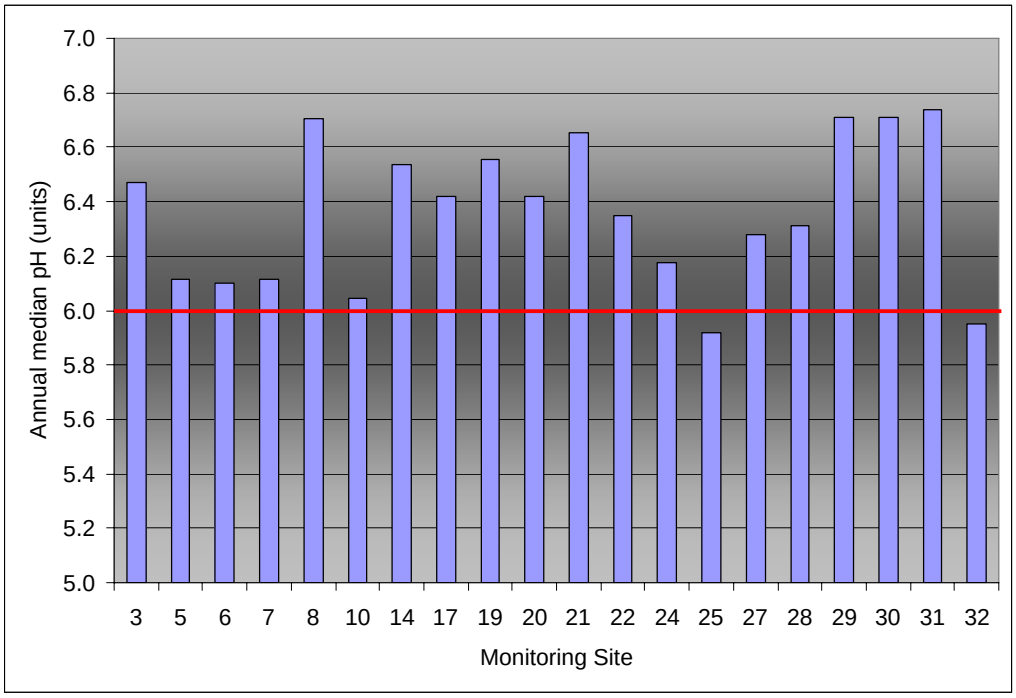
Table 3. Annual median values for water quality parameters, 2004. Values in red indicate observations that did not meet standards.

Site Number	Dissolved Oxygen (mg/L)	pH (units)	Conductivity (microS/cm)	Total Dissolved Solids (mg/L)	Temperature (Degrees C)	Ammonia (mg/L as N)	Nitrate+Nitrite (mg/L as N)	Phosphate (mg/L as P)	Turbidity (FTUs)	Alkalinity (mg/L CaCO3)	Calcium Hardness (mg/L CaCO3)	Flow m/s
WQ-03	8.3	6.5	54	34.9	14.58	<0.02	0.12	0.03	8	23	<10	0.12
WQ-05	8.9	6.1	123	78.6	11.67	0.07	0.22	0.01	12	30	<10	0.15
WQ-06	9.2	6.1	67	42.9	11.59	0.04	0.25	0.02	10	28	<10	0.52
WQ-07	9.5	6.1	76	48.9	11.46	<0.02	0.58	0.03	<5	20	13	0.30
WQ-08	8.8	6.7	105	67.4	13.86	0.02	0.29	0.04	<5	25	15	0.35
WQ-10	9.2	6.0	38	24.5	11.29	<0.02	0.11	0.03	9	23	<10	0.37
WQ-14	9.0	6.5	116	74.6	12.11	<0.02	0.32	0.05	<5	30	20	0.25
WQ-17	8.7	6.4	123	78.7	13.40	0.07	0.33	0.02	12	38	20	0.23
WQ-19	8.4	6.6	93	59.1	15.96	0.05	0.13	0.03	10	50	13	0.07
WQ-20	7.8	6.4	74	47.6	14.43	0.04	0.17	0.03	10	30	10	0.23
WQ-21	8.5	6.7	97	62.2	13.81	0.02	0.18	0.06	16	58	18	0.08
WQ-22	9.5	6.4	49	31.1	12.41	<0.02	0.12	0.04	8	28	<10	0.26
WQ-24	8.1	6.2	48	30.8	11.67	0.03	0.04	0.05	11	40	<10	0.34
WQ-25	6.2	5.9	52	33.9	12.81	<0.02	0.04	0.02	8	45	10	0.02
WQ-27	8.1	6.3	50	31.7	13.28	<0.02	0.04	0.02	<5	15	<10	0.06
WQ-28	8.7	6.3	91	57.8	15.34	0.04	0.24	0.03	10	28	10	0.19
WQ-29	7.5	6.7	81	52.1	16.01	0.04	0.25	0.05	8	30	13	0.15
WQ-30	9.0	6.7	80	51.2	14.28	<0.02	0.44	<0.01	<5	15	15	0.17
WQ-31	7.9	6.7	123	78.6	14.95	<0.02	0.32	0.01	<5	23	20	0.15
WQ-32	8.5	6.0	79	51.9	14.98	0.03	0.48	0.02	12	23	10	0.15

All streams possessed annual median dissolved oxygen concentrations that met Virginia's State Water Quality Standard (Table 3). Furthermore, dissolved oxygen concentrations were well above the 4.0 mg/L standard at most every site and month during 2004 due to sustained flows from adequate rainfall. Winterpock Creek (WQ-25) was the only stream where dissolved oxygen concentrations failed to meet the State's water quality threshold (May and June surveys). It is not uncommon to observe this as late spring and summer usually is the time in which flows are the lowest and the temperature of the water is the greatest. Since dissolved oxygen concentrations are inversely related to temperature (cold water holds more oxygen), dissolved oxygen levels are typically at their lowest during the this timeframe.

Only two streams had annual median pH values that were below the minimum threshold for acceptable water quality, down from 11 the previous year (Figure 1). Winterpock Creek (WQ-25) continued the trend of low pH value from 2002 and 2003 while one other (Proctors Creek, WQ-32) had an annual median pH value that fell below the threshold during this year. For the streams in which pH has been historically low, these observations may represent a naturally occurring condition. Many streams in Virginia are naturally acidic due to organic acids synthesized during decomposition of leaf litter and other plant matter. Continued monitoring should be able to ascertain the "normal" pH of these waters. No sites ever surpassed the maximum pH limit of 9.0 units.

Figure 1. Annual median pH observations among 20 sites within Chesterfield County, 2004. The red bar represents Virginia Department of Environmental Quality's minimum value water quality standard.



Annual median values for conductivity and total dissolved solids were all within expected limits for 2004. As in previous years, the streams within the Falling Creek watershed generally had higher conductivity and total dissolved solids values greater than the other streams and drainages, perhaps due to a difference in the underlying geology of the basin.

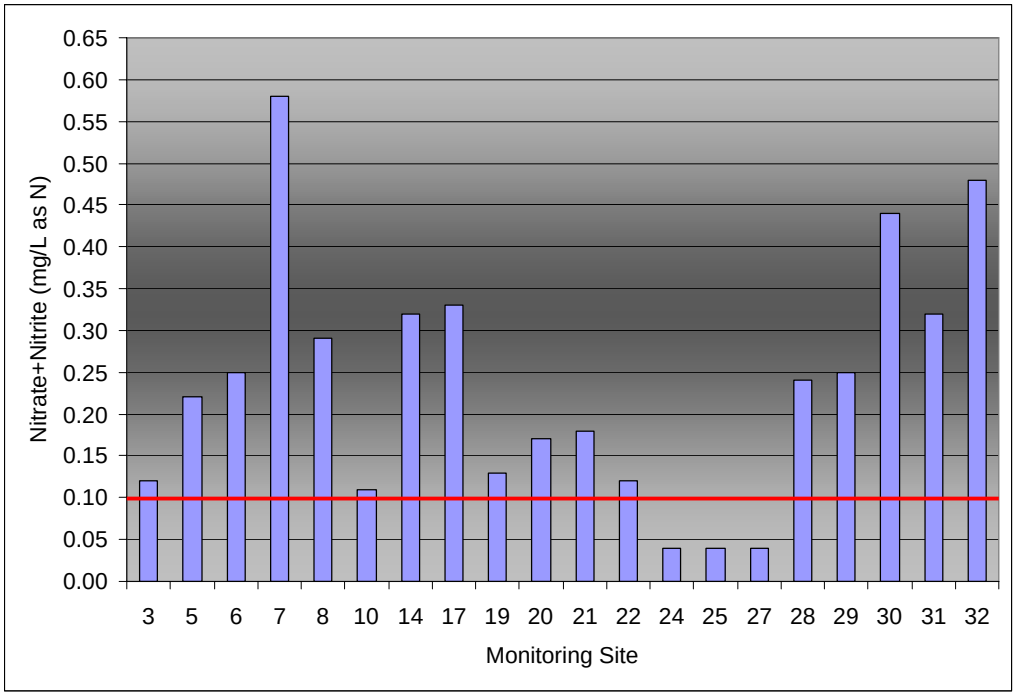
At all sites, temperature varied normally according to season and there were no observations that violated state water quality standards. Ambient air temperature during the surveys also varied seasonally and ranged from 5 – 34 ^{o}C.

All monitored streams had extremely soft water (< 80 mg/L $CaCO_3$), indicating the potential for increased metals toxicity should a spill or discharge occur (table 3). The soft water is reflective of Chesterfield County's geology and is not in and of itself an indication of poor water quality. Similarly, most all streams had annual median alkalinity values that characterized them as adequately or well buffered waters (>20 mg/L $CaCO_3$, table 3). However, the annual median alkalinity observed at Turkey Creek (WQ-27) and the Tributary to Michaux Creek (WQ-30) were indicative of streams in which the buffering capacity of the water was not as great as expected. These streams would be not be able to respond as rapidly to natural fluctuations in acidity without some impact on aquatic life. With the exception of the two new sites where

alkalinity was lower, all observations of hardness and alkalinity for 2004 were similar to conditions present in 2002 and 2003.

The majority of the streams monitored were not substantially impacted by ammonia nitrogen contamination. As in 2003, Redwater Creek (WQ-05; 0.07 mg/L N) and Falling Creek (WQ-17; 0.07 mg/L N) had the two greatest annual medians for ammonia nitrogen of all the streams investigated (Table 3). Both streams were rated as having low water quality and are in watersheds that are heavily developed.

Figure 2. Annual median nitrate nitrogen observations among 20 sites within Chesterfield County, 2004. The red bar represents the USEPA's local reference condition for Level III Ecoregion 45 streams.

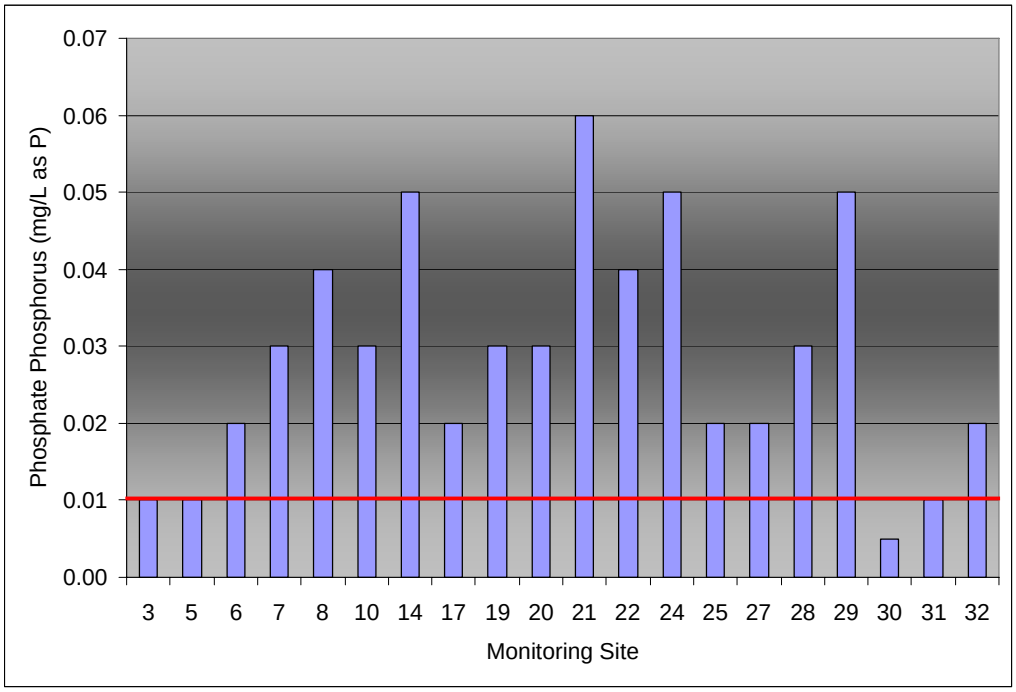


Seventeen streams had nitrate+nitrite nitrogen concentrations that exceeded the USEPA's reference condition for the ecoregion in which Chesterfield County is located (Figure 2). The greatest levels were observed at Kingsland Creek (WQ-07), the Tributary to Michaux Creek (WQ-30) and Proctors Creek (WQ-32). For the third year in a row, elevated nitrate+nitrite concentrations were observed at Kingsland Creek (WQ-07). Nitrate+nitrite nitrogen was the second most frequently observed pollutant in the monitored streams.

Sixteen of the streams monitored during 2004 had some degree of elevated phosphate phosphorus concentrations (Figure 3). The greatest annual median concentrations (≥ 0.05 mg/L as P) were observed at Pocoshock Creek (WQ-14), Spring Run (WQ-21), Cattle Creek (WQ-24)

and Spring Creek (WQ-29). This was the second consecutive year that Spring Run and the third consecutive year Cattle Creek exhibited relatively high phosphate phosphorus levels. The elevated levels observed at such a variety of sites with different land uses throughout the county over the course of several years indicate that phosphate phosphorus is the most ubiquitous pollutant.

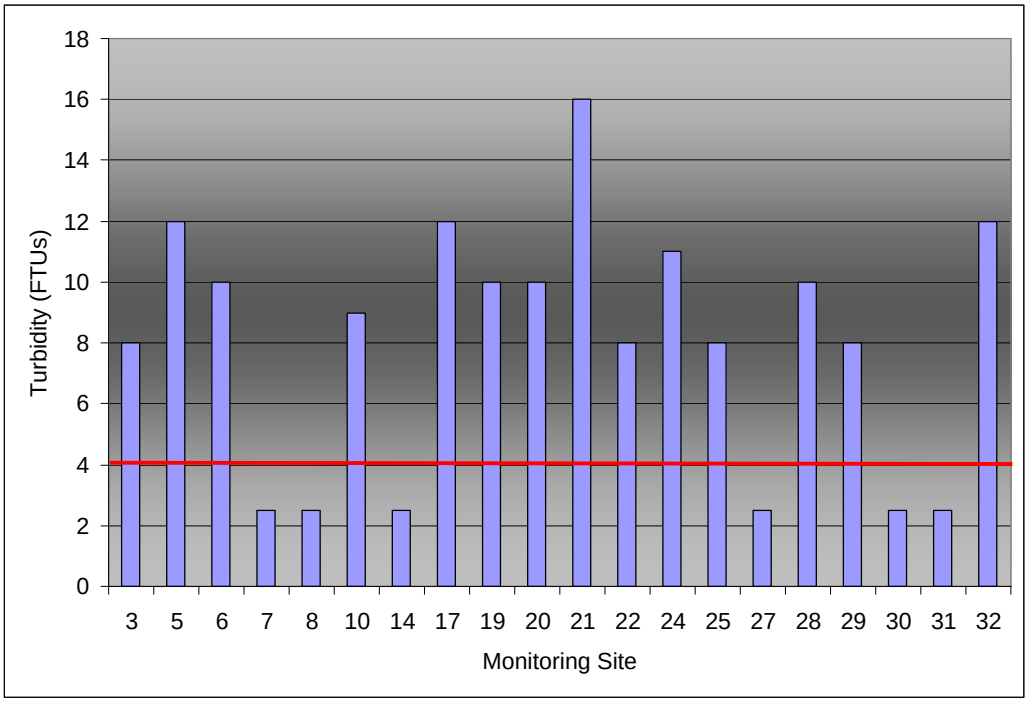
Figure 3. Annual median phosphate phosphorus observations among 20 sites within Chesterfield County, 2004. The red bar represents the Center for Watershed Protection's published ideal value for forested systems.



In 2004, six streams (WQ-07, WQ-08, WQ-27, WQ-30 and WQ-31) possessed annual median turbidities less than the 4 FTU local reference condition (Figure 4). The greatest turbidities (> 10 FTUs) were observed at sites WQ-05, WQ-17, WQ-21 and WQ-32 (Figure 4). This was the second consecutive year that Spring Run (WQ-21) exhibited relatively high turbidity.

Adequate rainfall for 2004 (approximately 55 inches reported by the Addison-Evans Water Treatment and Laboratory Facility) led to flows present at the majority of sites during the year. Low flows (<0.01 meters/second) were observed on occasion, most notable at Winterpock Creek (WQ-25) where downstream beaver activity has slightly impounded the stream. Other streams that recorded instances of low flow included Nuttree Branch (WQ-19) and Spring Run (WQ-21). None of the streams monitored ever went dry in 2004.

Figure 4. Annual median turbidity observations among 20 sites within Chesterfield County, 2004. The red bar represents the USEPA's local reference condition for Level III Ecoregion 65 streams.



Conclusions:

The overall chemical water quality within the monitored streams of Chesterfield County continues to be fairly good. There were no instances of substantially degraded conditions with only three sites scoring in the low water quality category. As in previous years, impacts to the streams were mostly attributed to low pH and high turbidities in conjunction with elevated nutrient concentrations. The majority (17) of the streams investigated during 2004 possessed moderate or high chemical water quality. Monitoring efforts will continue into 2005 with minor changes. Close attention will be paid to the Falling Creek and Pocoshock Creek Watersheds where monthly sampling will continue. Countywide sampling will be done on a quarterly basis at select sites. Additionally, efforts will be made to collect more supplemental samples as time and budget allows in order to better determine the water quality characteristics of stormflows.

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